HAWAII AGRICULTURAL EXPERIMENT STATION
E. V. WILCOX, *Special Agent in Charge.*

BULLETIN NO. 19

EXPERIMENTS IN TAPPING CEARA RUBBER TREES

BY

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[Under the supervision of A. C. TRUE, Director of the Office of Experiment Stations, United States Department of Agriculture.]

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LETTER OF TRANSMITTAL

HAWAII AGRICULTURAL EXPERIMENT STATION,
HONOLULU, HAWAII, *Dec. 28, 1909.*

SIR: I have the honor to transmit herewith and recommend for publication, as Bulletin No. 19 of this station, a report on experiments in tapping Ceara rubber trees. The report embodies the results of one year's experiments, which were undertaken to demonstrate the yield of latex from Ceara rubber trees, and, therefore, the commercial prospects of the industry in Hawaii; and also the relative value of different methods and times of tapping, and the possibility of utilizing Japanese laborers, such as are found on the rubber plantations, in the work of tapping and collecting rubber.

The funds of this station during the year of the experiment were not sufficient to carry on the rubber investigations. The Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii therefore kindly consented to co-operate with the station, furnishing funds to the extent of $1,200.00, which, at the suggestion of Mr. R. S. Hosmer, Territorial Forester, were allotted from the funds which had been assigned to the Division of Forestry. The funds were assigned with the understanding that the work should be under the supervision of this station. All details of the plan of the experiments were worked out by myself, in consultation with Mr. Hosmer, and the actual work of tapping was done by Mr. Q. Q. Bradford and laborers under his direction. It is also a pleasure to acknowledge the active cooperation of the directors of the four rubber plantations on Maui in allowing the tapping of their trees and in furnishing the laborers and accommodations for the assistant who had direct charge of the work.

Respectfully,

E. V. WILCOX,
Special Agent in Charge.

DR. A. C. TRUE,
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Publication recommended.
A. C. TRUE, *Director.*

Publication authorized.
JAMES WILSON, *Secretary of Agriculture.*

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EXPERIMENTS IN TAPPING CEARA RUBBER TREES.

INTRODUCTION.

The Ceara rubber tree has been grown in Hawaii in limited areas for fourteen years or more. It is only within the past four years, however, that commercial plantings of serious consequence have been undertaken. The chief rubber plantations at present are located on the island of Maui, but smaller plantings are found on Hawaii, Oahu, and Kauai. The area at present planted in rubber in the Territory is about 1,500 acres, of which about 1,300 acres are located on the windward side of Maui. The greater part of this area is planted in Ceara rubber, but there are also considerable plantings of Hevea and Castilloa. At present the new plantings which are being made are largely of Hevea rubber. Recently a few seed have been planted of *Manihot dichotoma* and *M. piauhiensis*. Limited numbers of *Ficus elastica, F. religiosa* and species of *Cryptostegia, Sapium, Kickxia, Calotropis*, and other genera of rubber trees are to be found in various localities.

While the Ceara rubber tree is considered as capable of thriving in a fairly dry climate, it has been found to grow much more vigorously where a generous rainfall is found, and the present rubber plantations are, therefore, located on the windward side of the various islands. With the change of opinion, which has recently been noted in nearly all rubber-growing countries, in favor of Hevea, as compared with Ceara rubber, most of the rubber plantations began to turn their attention more exclusively to Hevea, and some doubt was felt regarding the financial prospects from plantations of Ceara rubber. The experiments, which had previously been carried on in the Territory, and which were reported in Press Bulletin 13 and Bulletin 16 of this station, were necessarily on too

small a scale to allow of satisfactory conclusions as to the commercial importance of rubber in Hawaii. Occasionally, a doubt was expressed as to whether the location of these islands was not a little too far from the equator to insure any real success from rubber-growing.

Under the circumstances, it seemed necessary, particularly in view of the continued plantings which were being made, and the uncertainty of prospective yields, to undertake experiments which would shed light on the yield of latex to be expected from Ceara trees in the climate of the Hawaiian Islands, and on various other matters directly connected with the local conditions under which Hawaiian rubber plantations must operate.

THE YIELDS OF LATEX FROM YOUNG CEARA RUBBER TREES.

On account of the fact that rubber production is a new industry in the Territory, it is, of course, impossible to find large plantings of trees which are really old enough for commercial tapping. It is commonly recommended that trees should not be tapped until they are six to eight years old. There are only a few trees in the Territory of that age, and for purposes of comparison it is necessary to have a much larger number of trees. The majority of the trees tapped in the experiments reported in this bulletin were two or three years old. It was considered that the adaptability of Japanese labor to this work, and the actual time and expense of tapping trees and collecting rubber, could be determined on small trees, and that the yield which might be expected from mature trees could be determined with some certainty from the few large trees which are at present to be found in the Territory.

The first experiment was made in September, 1908, on 80 trees, averaging 13¼ inches in circumference at 3 feet from the ground. These trees averaged 23 feet in height and the branching began at about 10 feet from the ground. In this first series of 80 trees, which were tapped by means of 1 vertical cut each day, it required 36 hours and 40 minutes of labor to tap the trees, collect the latex, and secure, by coagulation, 1½ pounds of dry rubber. The trees were tapped by vertical cuts 7 feet in length, extending from the greatest height the laborers could reach, to a point near the ground. The cut was

made with a knife resembling an ordinary ferrier's knife, which removed a "v"-shaped strip of bark, extending nearly to the cambium. It was found somewhat difficult on new trees, with thin bark, to avoid injuring the cambium. This did not interfere with the flow of latex, but caused the healing scars to be irregular on many of the trees. The tapping was done at daylight, and the latex was collected as soon as the flow ceased. A spout, driven into the tree at the base of the cut, delivered the latex into the small pans, from which it was collected. On some days much difficulty was experienced in preventing the pans from being overflowed during excessively heavy rain storms. In this first series of trees it was found that four ordinary Japanese laborers could tap 80 trees in from 17 to 40 minutes. The men had never done any tapping previously, and required some instructions in the use of the knife and precautions to be observed. It required about two days for the laborers to become sufficiently expert to do the work without direct assistance and instructions. At the end of 15 days of tapping, they were able to tap a given number of trees in one-half the time which was required at the beginning.

In these, and the other experiments reported below, it was found that latex, unmixed with rain water, and in a thin layer in the bottom of the pan, would coagulate in about one-half hour. Latex, which remained attached to the side of the tapping wound was coagulated sufficiently for stripping off the scrap rubber, after one hour. When the latex was left at a depth of an inch or more in the pan, it sometimes required from one to two days for coagulation. The addition of water, either from rain or with deliberate intent, delayed coagulation considerably in every instance.

With regard to the economic handling of laborers in tapping rubber trees, it was found that the men could be kept at work for one-half day, at tapping and collecting, and that in the afternoon they could be utilized in washing rubber and utensils, or at cultivation or various other lines of work on the plantation.

In the second series of 160 trees, which were tapped with 2 vertical cuts, in the place of 1, it required only 40 hours of labor to tap the trees, collect the latex, and obtain 5 pounds of prime rubber and 2½ pounds of scrap rubber. With the present prices of rubber, it will be seen that when two vertical cuts were used daily profitable returns were obtained from

two-year-old trees. This result is encouraging when it is remembered that the labor of tapping the small trees is somewhat greater than that in tapping the large trees, and that the yield of latex is very much lower. With the same amount of labor, it is, therefore, possible to obtain a larger amount of rubber from mature trees. The small diameter of the trees, which did not average more than four inches, offered some mechanical difficulties in directing the knife so as to secure a reasonably straight cut. It is perfectly obvious, moreover, that a vertical cut in a tree of this small size, through a length of seven feet of the trunk, relieves the normal pressure inside the bark to such an extent that the flow of latex is continued for only a few minutes.

During these experiments it was found that one laborer can tap about 50 trees per hour, while another laborer can, in the same time, collect the latex from trees which would be tapped by two men. Since it appears, from subsequent experiments, which have been made in tapping mature Ceara rubber trees, that about one-third ounce of dry rubber may be expected as a daily yield from each tree, it is evident that three men should be able to obtain rubber from mature trees at the rate of about one pound per hour. The data, upon which this conclusion is based, have been carefully considered, and the estimate is probably not above that which may be normally expected. The rubber planters may, therefore, be reasonably assured that the Ceara rubber tree will not only grow and thrive in the Territory, but will yield profitable returns.

With trees four inches in diameter, it was found that the area of bark will allow tapping, with a single vertical cut daily, for two weeks in succession, or with two vertical cuts daily, for one week. In the case of larger trees, the tapping period may, of course, be much longer.

COMPARISON OF "V" CUTS WITH VERTICAL CUTS.

In October, 1908, 10 trees, averaging 25 inches in circumference, and of nearly mature age, were tapped for the purpose of comparing the yield obtained from "v" cuts and vertical cuts. The 10 trees were divided into 2 groups of 5 each, uniform in size and growth. The time required for making the two kinds of incisions was about the same in each case, being about 7 minutes for each group of 5 trees. The dry

rubber obtained from the 5 trees tapped with the "v" cut weighed 2⅛ ounces, and that from the 5 trees tapped with 2 vertical cuts weighed 6½ ounces. As was to be expected, the yield was much larger from the vertical cuts. This is in part, at least, due to the fact that the length of the incision is much greater with vertical cuts than with "v" cuts. The latex ran down to the pans somewhat more promptly from the vertical cuts, but the amount of scrap rubber left attached to the sides of the incisions was about the same in either case. Subsequent observations showed that the healing of the bark wounds took place about as soon in the case of vertical as in the case of "v" cuts, and the trunk ultimately became about equally smooth in either case. While the rate of flow downward, after issuing from the wound, was greater in the vertical cuts, the promptness and apparent pressure with which the latex issued from the wounds, was the same in both methods.

In November, 1908, 25 trees, averaging about 26 feet in height, and 20 inches in diameter, were tapped for 5 days in succession, making 14 vertical cuts 6 feet in length in the bark during this time. The purpose of this experiment was to determine whether there was any economy in using up all of the bark of the tree in a shorter time, by means of more cuts per day, than had been done in the previous experiments. The results indicated no advantage from the use of 4 vertical cuts daily, rather than 2. The amount of dry prime rubber obtained from 25 trees was 6.2 oz., and that of scrap rubber 6.1 oz.

As a further comparison of the yield from "v" cuts and vertical cuts, 8 trees on the station grounds, 14 inches in diameter, were tapped in December, 1908, 4 being tapped by either method. The results were again in favor of the vertical cut, whether or not a water-bag was used to wash the latex down into the pans and keep the wounds fresh. From the trees tapped with the "v" cut, 1.1 oz. of dry rubber was obtained, and those tapped with the vertical cut 0.9 oz.

TAPPING AT DIFFERENT HOURS OF THE DAY.

In November an experiment was carried out at Keanae, Maui, on 20 trees, averaging 15 inches, in circumference, five of the trees being tapped at 6 a. m., five at 8 a. m., five at 10 a. m., and five at noon. From a commercial standpoint, it is important to know how much time of each day may be profitably

devoted to tapping. If the tapping period were to be restricted to a few hours in the morning it would be a somewhat difficult matter to utilize the time of the laborers to advantage. The present experiment was, therefore, undertaken to determine the yield of latex at the four hours mentioned above. The weight of dry rubber obtained from tapping at 6 a. m. was 3.2 oz., at 8 a. m. 1.9 oz., at 10 a. m. 1.8 oz., and at noon 1.8 oz. From these results it is apparent that the yield is somewhat larger about daylight than at any subsequent time. The difference in yield, however, depends to a large extent on the climatic conditions. On clear days, with a bright sun, the flow of latex is much less after the sun is high in the sky than at daylight. On cloudy, cool days, on the other hand, the flow of latex is almost the same during any of the morning hours.

In order to gain additional evidence on the point in question, 30 trees, averaging 12 inches in circumference, were divided into three groups of 10 each, and were tapped at daylight, 10 a. m., and 1 p. m., respectively. In a period of one week 1.6 oz. dry rubber were obtained from the 10 trees tapped at daylight, 1.6 oz. from those tapped at 10 a. m., and 0.8 oz. from those tapped at 1 p. m. The weather was, on the whole, favorable to tapping quite late in the day. The conclusions which are to be drawn from these experiments, and other occasional tappings which we have made, indicate that, under ordinary conditions, it will be profitable to tap trees from daylight until nearly noon. On very hot, clear days, however, the later morning tappings may as well be omitted, or, in other words, the operation of tapping may, on such days, be better confined to the early morning hours.

Another experiment, to gain evidence on the importance of the time factor in the flow of latex, was carried out on Tantalus. In this test the yield from four trees tapped at 6 a. m. was 1.1 oz., at 8 a. m. 1.3 oz., at 10 a. m. 0.9 oz., and at 12 m., 0.3 oz.

THE USE OF WATER-BAGS TO WASH DOWN THE LATEX.

The openings of the latex tubes in the tapping wounds of Ceara rubber trees are sealed up within a few minutes, under ordinary conditions; and the flow stops. It was thought

advisable, therefore, to determine whether the wounds could be kept fresh and the length of flow increased by the use of a water-bag from which the water dripped slowly down the tapping wound. The results of this test indicate clearly that the yield may be somewhat increased by the use of the water-bag and the flow maintained for a somewhat longer time. The yields in one test were 0.8 oz. dry rubber with the use of the water-bag, and 0.5 oz. without. In the second test, 0.5 oz. with water, and 0.4 oz. without; and in the third test, which was made late in the day, 0.2 oz. with water, and .07 oz. without. While it appears certain, therefore, that the use of the water-bag will somewhat increase the yield, the economy of the operation is a matter which cannot be determined by experiments on a small number of trees, but only by making a test on a commercial scale when the rubber trees come to a mature age.

It was thought to be desirable to repeat the experiment with water-bags in another locality, the previous experiment having been carried out on Tantalus. The second test was made at Keanae, Maui, on 10 trees averaging 15 inches in circumference. In this experiment it was found that on hot, clear days the latex did not flow down to the pan on certain trees on which the water-bag was not attached. The yield, however, for the whole tapping period of two weeks, from the 5 trees on which water was used, was 3.5 oz., and from the 5 trees without water, 5.6 oz. This variation may possibly have been due in part to the unequal yielding power of the two sets of trees, but, at any rate, does not indicate any advantage from the use of the water-bag.

THE EFFECT OF NITRATE OF SODA UPON THE FLOW OF LATEX.

While fertilizers have been used in rubber plantations for increasing the growth and vigor of rubber trees, we have found no record of experiments to determine the possibility of increasing the flow of latex temporarily during the tapping period. It is apparent that if the flow can be considerably increased by the application of a quick-acting fertilizer, economy will be secured in the operations of tapping and collecting latex. The first experiment with nitrate of soda was carried out at Keanae, Maui, on Ceara rubber trees averaging 14 inches in circum-

ference. A uniform series of trees was found and divided into three groups which received one-half pound, one-fourth pound, and no nitrate of soda, respectively. Before applying the nitrate of soda, the yield of the whole group of trees was tested by means of uniform tapping. The weight of dry rubber from 3 trees, which received one-half pound of nitrate of soda each, was 2.3 oz.; from 3 trees, which received one-fourth pound of nitrate of soda, 1.3 oz.; and from the 3 unfertilized trees, 1.2 oz. The nitrate of soda was placed in the soil at a depth of three or four inches and at some distance from the trunk, around each tree, where it would most quickly become available to the roots. The weather was rainy during the experiment, which extended over a period of about two weeks, and the nitrate of soda was, therefore, rapidly dissolved and utilized by the tree, or washed away in the drainage water. The effect of the nitrate of soda upon the flow of latex was manifested within 48 hours.

A similar experiment was made on rubber trees growing on Tantalus, averaging about 12 inches in circumference. The soil about these trees was very loose and porous, and at the time when the nitrate of soda was applied, was unusually dry. After applying the nitrate of soda, the soil was thoroughly irrigated. The results from tapping these trees indicated that the nitrate of soda was almost entirely washed away by the heavy irrigation, so that little effect was noted in the amount of rubber obtained from trees to which the fertilizer had been applied. The flow of latex, was, however, in all cases, somewhat more vigorous from trees which had received nitrate of soda, and coagulation of the rubber from the latex took place more promptly. In a subsequent test, in the same locality, upon other trees, the yield of rubber was doubled by the application of one-half pound nitrate of soda per tree. In this case, the soil was moist at the time of the application of the fertilizer and no irrigation was applied during the experiment. Under ordinary conditions, on the windward side of the islands, the soil is sufficiently moist at all times to render the nitrate of soda promptly available.

The matter of the influence of nitrate of soda upon the flow of latex was considered sufficiently important to be put to a further test on rubber trees near the station office. These trees were about 11 inches in circumference. From one group of 5 trees 0.9 oz. of dry rubber was obtained in 3 days, before

applying the nitrate of soda, and 1.3 oz. from the same trees, in the three days following the application of the fertilizer. In this case, each tree received one-half pound nitrate of soda. On another group of 5 trees, the yield of rubber during the 3 days before the nitrate of soda was applied, was 0.9 oz., and during the three days following its application, 1.2 oz. It appears, from these experiments, that the flow of latex may be temporarily stimulated by applying nitrate of soda. It now remains for the planters to determine the exact economy of the method by applying it on a large scale as soon as rubber trees become mature.

RETAPPING TREES WHICH HAVE RECENTLY BEEN TAPPED.

The tapping wounds of Ceara rubber trees heal over promptly and smoothly if the operation of tapping has been done with ordinary care. Where the cuts have been made too deeply and have involved the cambium layer, the scar tissue is rough and furnishes some difficulty in subsequent tappings. This trouble, however, is less pronounced on mature trees than on young and rapidly growing trees. In order to determine the rate of flow from scar tissue of trees recently tapped, as compared with the flow from trees of similar age and size, not previously tapped, 20 trees were selected on Maui and divided into two groups of 10 each, one of which had been tapped four months previously, while the other had never been tapped. This test does not give a correct indication of the promptness with which trees recover from previous tappings, for the reason that the trees in question had been too deeply tapped before, and the healing wounds were too rough and irregular. Some of the latex, therefore, did not flow into the pans and was consequently lost. The yield from the 10 untapped trees, averaging 15 inches in circumference, was 4.1 oz. of dry rubber, as compared with 2.2 oz. of dry rubber from the 10 trees which had been tapped four months previously. From this experiment, and also from other occasional tappings which have been made, it appears probable that the Ceara rubber trees in Hawaii may be profitably tapped about three times annually.

YIELDS FROM NEARLY MATURE TREES.

As already indicated, the number of Ceara rubber trees, which have reached the age and size for commercial tapping

in Hawaii is very small. Such trees have occasionally been tapped to determine the yield of rubber per day, and the results from these isolated experiments are in essential agreement. They indicate a yield of about one-third ounce of dry rubber per day from 5-year-old trees. Mr. W. M. Giffard, of Honolulu, kindly had some careful tapping tests made of three 5-year-old trees on the Maunawili Ranch. The trees were first tapped for a period of twelve days to a height of three feet and eight inches from the ground. The average yield per tree in these experiments was one-fourth ounce of dry rubber daily. Subsequently, the same trees were again tapped above the previous tapping wounds, using the same method of nearly vertical cuts. The second test also extended over twelve days and gave an average yield per tree of one-third ounce dry rubber daily. These two experiments were in a locality where the average rainfall is about 100 inches per year.

THE DISTRIBUTION OF THE LATEX TUBES.

It was thought that a study of the course and distribution of the latex tubes in the different species of rubber trees might give a basis for the methods of tapping which would give the largest yields of latex. Attention was naturally given largely to the Ceara rubber tree for the reason that this is the only species grown on a commercial scale in Hawaii which has reached a size sufficient for tapping. It was soon found, however, that the lateral connections between the latex tubes in the bark of Ceara give an opportunity for the rapid outflow of latex. This was apparent, both from a microscopic examination of numerous sections from the bark and wood of Ceara rubber trees, and also from practical tapping experiments. As indicated above, the flow of latex appears to be as prompt and vigorous from a "v" cut, at an angle of 45 degrees, as from a vertical cut; but no more so. Throughout this bulletin vertical cuts have been spoken of, although they are not strictly vertical. The cuts are nearly vertical until they reach the base of the tree, where they are curved in to one point to the spout driven into the trunk at that place. In most of the experiments the vertical cuts have been so made as to gradually cover one-half of the tree, the first two cuts being farthest apart at opposite sides of the tree, and converging to a point below. Subsequent cuts are made in pairs inside of the first pair until

the bark of one-half the trunk is used up. The same process is then repeated on the other side of the tree. The fact that the flow from vertical cuts equals that from "v"-shaped cuts, at an angle of 45 degrees, indicates that the latex readily escapes from lateral connecting branches between the longitudinal trunks of the latex system.

The following notes were made in a microscopic examination of sections from different species of rubber trees growing on the station grounds: In *Kickxia,* the latex tubes are distributed chiefly just underneath the epidermis, immediately outside of the cabium, and in the outer part of the pith bordering the wood tissue. There are numerous strands of the latex system connecting the latex tubes in the outer and inner portions of the bark. The inner group of the bark latex tubes is separated from the cambium by merely a few layers of parenchymatous cells. In Hevea, the main latex system is in one belt, located about half way between the epidermis and the cambium. There are no latex tubes in the pith. In *Ficus,* the latex tubes are chiefly found in the bark near the cambium. In the young growth, however, they occur throughout the pith. In *Cryptostegia,* the latex tubes occur on either side of the cambium and very abundantly throughout the pith. In *Castilloa,* the main latex system is in the bark, but a few strands of latex tubes are located in the pith, immediately underneath the wood tissue. In Ceara rubber trees, the latex tubes are found almost exclusively in the bark outside of the cambium. In order to obtain a full yield of latex, therefore, it is unnecessary to injure the cambium. The large number of connecting tubes between the main longitudinal trunks is conspicuous in Ceara rubber trees and accounts for the ready flow of latex from tapping wounds in any direction.

INTER-CROPS IN RUBBER PLANTATIONS.

In view of the fact that no returns can be expected from rubber trees until they are 6 to 8 years old, it seems desirable to utilize the ground between the trees during their early growth. For this purpose, several crops are well suited. During the past year about 100 acres of corn were grown in young rubber plantations with good results. The yield varied from 35 to 40 bushels per acre, even where the annual rainfall was 240 inches. Soy beans and other legumes, as well as rice hay,

may also be grown under the same conditions. Such cultures not only furnish crops which are valuable for forage or for other purposes, but also make it necessary to cultivate the soil, which, in turn, is good for the rubber trees, and reduces the expense of weeding. The favorable results, which have already been obtained from inter-crops in rubber plantations, have induced the planters to arrange for still larger operations along this line during the coming year. The ground between the trees can be utilized for other crops for the first two or three years. The planting distance, which was first adopted for rubber trees, was too close; but there is now a tendency to plant the trees about twenty feet apart each way. This leaves plenty of room for the economic utilization of the soil for other crops.

CULTIVATION OF RUBBER PLANTATIONS.

As already indicated, the cultivation of the soil between rubber trees by the growing of inter-crops has been found beneficial to rubber trees. Where the practice of inter-cropping is not adopted, it is necessary, for the best results, that the soil be well cultivated. Formerly the opinion prevailed that rubber could be treated as a forest tree and that cultivation might be neglected. A comparison of cultivated and uncultivated rubber trees, however, shows that the rate of growth, particularly in the young trees, may be nearly doubled by cultivation. Cultivation will, therefore make it possible to bring the trees to a size suitable for tapping at least one year earlier than would otherwise be the case. The saving of one year is an important factor in commercial success with rubber. Wherever possible, the best results are secured from plowing the ground before planting, followed by cultivation during the growth of the trees. If no cultivation is practiced until the trees are two or three years old, it is necessary to proceed carefully, since otherwise the superficial roots might be badly injured. Where cultivation is practiced from the start, however, the roots are forced deeper into the soil and no injury results.

MARKET VALUE OF HAWAIIAN RUBBER.

It was, of course, highly desirable to get expert opinion on the commercial value of rubber produced in the Territory. For

this purpose, samples were sent to A. T. Morse and Company, of New York City, and Siegmund Robinow of Hamburg. The samples sent to A. T. Morse and Company were ordinary biscuits obtained in the tapping experiments. The report of this company follows:—

"This seems to us to be of the same general nature as rubber now coming from Ceylon and the Straits Settlements. This rubber has developed very materially the last few years and is now a regular article of commerce. The most of the trees or plants which were originally started in Ceylon and the Straits Settlements came from Ceara, so it would be presumed that the plant is much, if not exactly, the same as the ones you have in Hawaii. The market price of the rubber to-day is about $1.27 per lb., less the charges of say, a brokerage, banker's commission, etc., which would amount to about 2 per cent. It seems to us that this sample is a trifle softer than most of the rubber coming from Ceylon and the Straits Settlements, but we have no doubt but what it is the same general quality and that the people in Hawaii can produce the same results as the Ceylon and Straits Settlements."

The price of prime Para rubber, at the same date, was $1.31 per pound.

The samples sent to Siegmund Robinow included fine yellow biscuits, containing some bark and dirt, similar biscuits without impurities, mixed scraps, and fine rubber, prime rubber which had been kept on hand for one year, and ordinary scrap rubber stripped from the sides of the tapping wounds. The prices quoted by Siegmund Robinow varied from 80 cents per pound, for ordinary scrap rubber, to $1.31 per pound, for prime biscuits. The price for prime Para rubber, on the same date, was $1.36 per pound. These figures must be considered very satisfactory when it is remembered that the rubber in the submitted samples was obtained from 2- and 3-year-old trees. The rubber from young trees is known to contain more resin and protein than that from older trees, and it is, therefore, slightly less valuable.

CONCLUSIONS.

So far as can be judged from the experiments outlined above, it appears that Ceara rubber trees will grow in a satisfactory manner in numerous localities in the Territory, particularly on the windward side of the islands. The labor upon which the planters must depend can readily be trained to do the work of tapping and collecting the latex. The yields from young trees indicate that good profits will be obtained from

Ceara rubber trees as soon as they reach a suitable size and age. The most rapid and vigorous growth of Ceara trees can be brought about only by cultivation of the soil. In localities where the ground is too rough for general cultivation, thorough hand-cultivation should be carried on around the trees. In order to obtain returns from the plantations before the rubber trees come into bearing, it seems wise to grow inter-crops.

A general fertilizer experiment has been planned and will be put into operation during the coming season. The purpose of this experiment is to test the utility of various fertilizers in promoting the growth of rubber trees, and to gain further evidence of the economy of temporarily stimulating the flow of latex during the tapping period. During the coming season chemical investigations will also be made on the composition of latex and the crude rubber, with reference to the improvement of methods of coagulating the rubber so as to free it, as far as possible, from impurities.